Rule CIC290: Open (L8) TCBs reached MAXOPENTCBS limit

Finding: The peak number of open (L8) Task Control Blocks (TCBs) in use for the CICS-DB2 connection reached the limit set by the MAXOPENTCBS parameter specified in the System Initialization Table (SIT).

Impact: This finding should normally have a HIGH IMPACT on the performance of CICS tasks in the region that use the CICS-DB2 connection.

Logic flow: This is a basic finding, based upon an analysis of the CICS statistics.   This finding applies only with CICS/Transaction Server for OS/390 Release 1.3 and subsequent releases of CICS, and only when CICS is connected to DB2 Release 6 and subsequent releases of DB2.

Discussion: When CICS is connected to DB2 Version 6 or later, the CICS-DB2 Attachment Facility uses open (L8 mode) TCBs to access DB2 rather than privately managed subtask TCBs.

CICS manages a pool of open TCBs up to the limit set by MAXOPENTCBS. At any one time, the pool can consist of some TCBs that are allocated, and others that are free. CICS attaches a new TCB only when there isn't a free TCB available in the pool. For example, if the maximum number of open TCBs is set at 100, the pool could consist of 50 open TCBs, not all of which are allocated.

The TCBLIMIT attribute of the DB2CONN definition governs how many of the open TCBs can be used[1] to access DB2.

If the TCBLIMIT is reached, the CICS DB2 task-related user exit can obtain an open TCB from the pool controlled by MAXOPENTCBS, but it must wait before it can use the open TCB to run a thread into DB2. When another task stops using its open TCB to run a thread into DB2, the number of open TCBs in use falls below TCBLIMIT and the waiting task is allowed to use its own open TCB[2] to run a thread into DB2.

If CICS dispatcher receives a request to allocate an open TCB (for a task that does not already have one), and it can't find a suitable match with a

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[1]The CICS-DB2 Attachment Facility will issue message DFHDB2211I if an attempt is made to connected CICS to DB2 Version 6 or later and that the setting of MAXOPENTCBS in the SIT is lower than the TCBLIMIT setting in the DB2CONN definition.

[2]However, if MAXOPENTCBS is reached, no more open TCBs are allowed in the CICS region, and the CICS DB2 task-related user exit cannot even obtain an open TCB for its use. It must wait until an open TCB is released by another task and returned to the pool controlled by MAXOPENTCBS, when it can use the released open TCB.

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free TCB, CICS dispatcher attaches a new TCB to satisfy the request. CICS can match a request with an available TCB of the correct mode only if the TCB has the right attributes. For example. in the case of a request for an L8 mode TCB, a free TCB can be allocated only if it is associated with the correct subspace.

The *CICS Performance Guide* describes the process of allocating an L8 mode TCB, as summarized in the following steps:

C If the transaction already has an L8 mode TCB allocated, it is used.

C If there is a free L8 mode TCB for the correct subspace, it is allocated and used.

C If the number of open TCBs is below the MAXOPENTCBS limit, a new L8 mode TCB is created, and associated with the task's subspace.

C If the number of open TCBs is at the MAXOPENTCBS limit, but there is a free L8 mode TCB with the wrong subspace, dispatcher destroys it and creates a new one for the required subspace. This technique avoids suspending the task until the number of TCBs is below the pool limit, and is called "TCB stealing," deleting a free TCB of one type in order to attach one of a different type. This "TCB stealing" action is recorded in the CICS dispatcher TCB mode statistics under the count of "TCB steals."

   During the "TCB steal" process, the task is suspended (with an OPEN_DEL wait). The OPEN_DEL wait simply means that the dispatcher is detaching an unsuitable TCB (stealing) so that it can allocate a new one, and the task is waiting for the old TCB to terminate so that dispatcher can attach a new one.

C If the number of open TCBs is at the MAXOPENTCBS limit and there is no free open TCB to steal, the dispatcher places the requesting task onto a queue and the task is suspended (using suspend token AWAITING_OPENPOOL_TOKEN in the DS task block). When an open TCB becomes free, or the MAXOPENTCBS limit is raised, the task at the front of the queue is resumed, and the open TCB allocation process is retried.

If MAXOPENTCBS is lower than TCBLIMIT, the system may run out of open TCBs before it reaches TCBLIMIT. Message DFHDB2211I will be issued during startup if the CICS-DB2 Attachment Facility detects that CICS is connected to DB2 Version 6 or later, and that the setting of MAXOPENTCBS in the SIT is lower than the TCBLIMIT setting in the DB2CONN definition.

Considering the performance penalties of not having an available TCB to use, there might be an inclination to simply specify a large value for the MAXOPENTCBS. However, there can be serious performance implications of specifying a MAXOPENTCBS value that is too large. As examples:

C **TCBs require storage**. The CICS-DB2 attachment facility attempts to attach a TCB on which a DB2 thread was to be created to service the SQL request from an application. If the attach of the TCB fails due to lack of storage, the transaction is abnormally terminated with a transaction dump.

C **TCBs require processor resources**. The MVS dispatcher must scan the TCBs to identify an active TCB. If there is a large number of TCBs, there could be a significant cost of processor time.

Consequently, there is a trade-off between specifying a sufficiently large number of TCBs and specifying an excessively large number of TCBs.

CICS Dispatcher statistics are available in MXG file CICDS. The MXG DSGNTCBL variable contains a count of the number of times the MAXOPENTCBS limit was reached. CPExpert produces Rule CIC290 when the DSGNTCBL value was greater than the **MXOPNTCB** guidance variable in USOURCE(CICGUIDE). The default value for the MXOPNTCB is 0, indicating that CPExpert will produce Rule CIC290 whenever the MAXOPENTCBS limit was reached.

Suggestion: You should consider the following alternatives if Rule CIC290 is produced:

C **Increase MAXOPENTCBS value in the SIT**. To ensure that you have enough open TCBs available to meet your DB2 workload, set the limit in your MAXOPENTCBS system initialization parameter to a value greater than the limit set in the TCBLIMIT attribute of your DB2CONN definition. If MAXOPENTCBS is lower than TCBLIMIT, the system may run out of open TCBs before it reaches TCBLIMIT.

When CICS connects to DB2, a warning message, DFHDB2211, is issued if the CICS DB2 attachment facility detects that CICS is connecting to DB2 Version 6 or higher, and that the setting of MAXOPENTCBS in the SIT is lower than the TCBLIMIT setting in the DB2CONN definition. If you receive this warning message, adjust your MAXOPENTCBS limit.

C **Modify guidance**. You can modify the MXOPNTCB guidance variable in USOURCE(CICGUIDE) if you feel that Rule CIC291 is produced prematurely.

Reference: *CICS/TS Release 1.3 CICS Performance Guide*: APPENDIX1.1.1.5.1
(Dispatcher domain: Global statistics)

CICS/TS for z/OS Release 2.2 *CICS DB2 Guide*: Section 5.4 (How threads
are created, used, and terminated)

CICS/TS for z/OS Release 2.2 *Resource Definition Guide*: Section 2.3.4
(DB2 connection definition attributes)

CICS/TS for z/OS Release 2.2 *CICS Performance* Guide: Section 4.8.6
(Setting TCBLIMIT, THREADLIMIT and MAXOPENTCBS for the CICS DB2
attachment facility)